THE ROLE PLAYED BY BLOCKING OVER THE NORTHERN HEMISPHERE ON HURRICANE KATRINA

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ABSTARCT

On year 2005, there exist 28 tropical Atlantic storms and hurricanes according to the Saffir- Simpson scale. Among of these, there existed three outstanding huge hurricanes, Katrina, Rita and Wilma with surface wind more than 150 Knots. The present paper investigates the role played by the blocking system over the northern hemisphere on hurricane Katrina. The 6- hour and daily NCEP/NCAR reanalysis data composites for the meteorological elements (surface pressure, surface wind, precipitation rate and geopotential height at 500 mb level) over the northern hemisphere for August 2005 has been used through this study. In addition to that, satellite images for hurricane Katrina and its hazards have been used. These datasets have been analyzed using of anomalies methodology. The results revealed that there existed a diffluent block persisted over Siberia and associated with a huge westerly air current aloft over the north America from 22 to 31 August 2005. Also, a strong westerlies air current aloft existed over the north Atlantic region. Splitting of westerlies occurred over the north Atlantic and it has two appreciable branches. First one goes toward the north and the second one to the south direction toward of the tropical Atlantic region. The splitting of main air current over the north Atlantic exist an unusual strong north east and easterly wind in the tropical Atlantic region. These unusual winds that caused by the blocking system in the northern hemisphere circulate, accelerate and control the track of hurricane Katrina from 23 to 31 August 2005. Whereas, analysis of the 10- day mean anomaly of the geopotential height at 500 mb for the northern hemisphere for August month of 2005 year revealed that there is an outstanding positive anomalies more than + 200 m over the north America simultaneously with positive anomalies more than + 150 m over Siberia occurred only during the last 10 days of August 2005.

1. INTRODUCTION

The 2005 hurricane season will long be remembered of the tropical Atlantic storms for several decades. This season has 28 tropical Atlantic storms, among of these, three huge hurricanes Katrina, Rita and Wilma within surface wind speed more than 150 Knot had been existed, NCDC (2005). The Katrina is a strong hurricane of Category 5 on Saffir - Simpson scale and has sustained wind speeds reached of 150 Knot, the Saffir-Simpson hurricane Scale is a 1-5 rating based on the hurricane's present intensity, Zebrowski and Judith (2005). Hurricane Katrina initiated over the tropical Atlantic region on 23 August and remains to 31 August. It caused extended hazards. The damage is around 60,000,000,000 Dollars, and displaced persons 500,000 and another 1,053 dead. Katrina makes landfall in Gulfport, Mississippi - deadliest hurricane to hit the United States since 1928. New Orleans 80% inundated after several levees burst around Lake Ponchartrain, water up to 20 feet deep in places. Katrina shut down an estimated 95 % of crude production and 88 % of natural gas output in the Gulf of Mexico, MODIS observation of flooding around Lake Ponchartrain on August 30, 31. Fig. (1) shows the hurricane Katrina, its track through the Gulf of Mexico and hazards. There are several papers cover the tropical storms and its hazards and damages, [Sallenger, (2000), Gray, (2001), Zebrowski and Judith (2005), and recently Asbury (2006)]. The are several literatures concerning the formation, persistence, the effect of Atlantic blocking action upon European weather and climate, and the role of blocking systems in the northern hemisphere climate variability, [Rex, (1950a, 1950b, and (19 51), Dole, (1978 and 1982), Hafez, (1997 and 2003), Cohen, et al., (2001) and Hasanean, and Hafez, (2003)]. According to almost of these studies, for blocking systems, the anomalies of the geopotential height at 500 mb over the northern hemisphere should be more that + 100 (m) and persisted at least 7 days. The present work aims to uncover the role played by blocking systems existed over the northern hemisphere through the period 22-31 August 2005 on the hurricane Katrina.

2. DATA AND METHODOLOGY

The 6- hour and daily NCEP/NCAR reanalysis data composites for the meteorological elements (surface pressure, surface wind, precipitation rate and geopotential height at 500 mb level) over the northern hemisphere for August 2005 (Kalnay, et al., (1996)) has been used through this study. In addition to that, satellite images for hurricane Katrina and its hazards have been used. Images obtained from NASA's Earth Observatory and from Jeff Schmaltz, MODIS Land Rapid Response Team at NASA Goddard Spaceflight Center. In the present work, these datasets have been

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analyzed using of anomalies methodology and linear correlation coefficient techniques, Spiegel (1961). The anomalies in the geopotential height at 500 mb level over the northern hemisphere during the period of study (month of August 2005) have been analyzed. Whereas, the anomaly in the geopotential height is (A´). This anomaly is calculated as the difference of the mean of the geopotential height (A) and its climatic mean value for each grid point . Whereas, the climatic mean values for the geopotential height have been taken through the period (1968-1995).

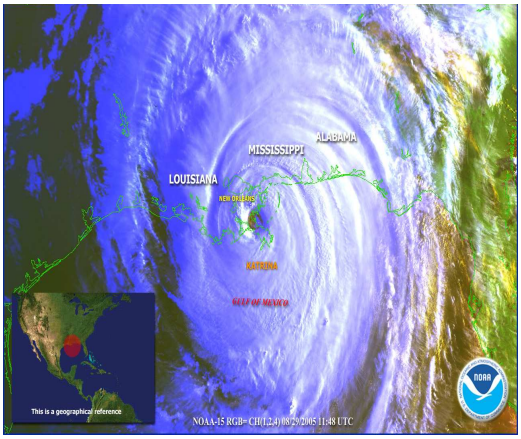
3. RESULTS

There existed three violent Atlantic storms with category 5 through the hurricane season 2005. Hurricane Katrina initiated on 23 and stayed to 31 August, with maximum surface wind reached to 150 Knot and lowest surface pressure 902 mb on 28 August over the Atlantic Ocean at location of (Lat. 26.3º N– Lon. 88.6º W). For hurricane Rita it has 155 Knot, record 897 mb surface pressure, and existed from 18 to 26 September. Wilma has 160 Knot and 882 mb at the surface with duration from 15 to 26 October 2005. The present work challenges the hurricane Katrina. Analysis of the 10- day mean of the northern hemisphere geopotential height anomalies at 500 mb level during the month of August 2005 revealed that there existed a diffluent block over Siberia through the last 10 days period, 21-31 August only. The block over Siberia has maximum positive anomalies +150 (m) at the north and minimum negative anomalies –150 (m) at the south. During the last 10 days, there existed a huge remarkable abnormal high pressure system over the northern America with maximum anomalies + 200 (m) accompanied with abnormal low pressure over north Atlantic with minimum anomalies - 200 (m), as shown in Fig. (2) and Table (1). From the analysis of the daily mean of the northern hemisphere geopotential height anomalies (m) at 500 mb level for the period 22-31 August 2005 it is clear that the unusual pressure system over the northern hemisphere over Siberia, north America and north Atlantic persisted for 9 days (23 to 31 August). Table (2) illustrates the distribution of the geopotential height anomalies over the northern hemisphere though the period of study. The daily mean of anomalies of the meridonal, zonal wind, and precipitation rate in the tropical Atlantic and America through the period of 22-31August 2005 has been analyzed. The results show that the tropical Atlantic region and America lay under a couple of abnormal two different types of meridonal and zonal winds. In addition to that, there existed a maximum anomalies of precipitation record + 90 (mm/day) on 29 August as illustrated in Table (3). The correlation coefficient between the anomalies of the geopotential height over the northern hemisphere and the anomalies in the meteorological elements in regions of tropical Atlantic and America has been studied. The results revealed that, there are significant correlations (+0.75 and +0.60) between the anomalies in the geopotential height at 500 mb level over north America and Siberia, and the precipitation rate of the tropical Atlantic and eastern America respectively. In addition to that, there is a significant negative correlation (-0.60) between the anomalies in the geopotential height at 500 mb level over north Siberia and the anomalies in the meridonal wind over tropical Atlantic region and eastern of America as shown in Table (4).

4. DISCUSSION AND CONCLUSION

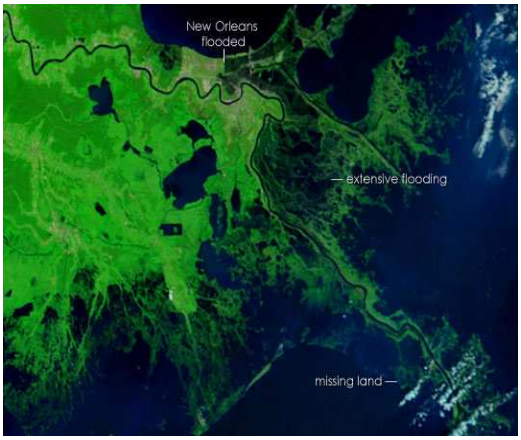
The diffluent block system that persisted over Siberia prevents the huge westerly air current aloft that existed over the northern America to across the Atlantic Ocean toward Europe for 10 days started from 22 to 31 August 2005 . The huge air current persisted Simultaneously over the North America almost of the hurricane Katrina duration. This long persistence of the two pressure systems over Siberia and North America was generate a splitting of westerly air current over Atlantic Ocean into two distinct branches of air currents. First branch moved northward toward the north of Atlantic Ocean and caused unusual sever weather over the northern Atlantic region. Second one goes southward toward south of the Atlantic Ocean and generated abnormal north east to east air current over the tropical Atlantic region. During the period of 22-31 August 2005, the Gulf of Mexico lies under the inference of two different abnormal strong winds. In one hand, there existed strong east - north east winds in the tropical Atlantic. In the other hand, there are strong south winds in the eastern south part of America. These two types of winds putting the Gulf of Mexico under the torque force of huge winds. This torque in the Gulf of Mexico, accelerates, circulates hurricane Katrina, and control its track through the Gulf of Mexico and changes the track of Katrina from south to the north toward land, and leads Katrina to landfall in Gulfport. The correlation coefficient analysis between the anomalies of the geopotential height over the northern hemisphere and the anomalies in the meteorological elements in regions of tropical Atlantic and America has been has been done. The results revealed that, there are significant correlations between the anomalies in the geopotential height at 500 mb level over north America and Siberia, and the precipitation rate in the tropical Atlantic and eastern America through the period of 22-31 August 2005. In addition to that, there is a significant correlation between the anomalies in the geopotential height at 500 mb level over north Siberia and the anomalies in the meridonal wind over the tropical Atlantic region and eastern of America through the same period. One can conclude that, the blocking systems over the northern hemisphere through the period 22-31 August 2005 control the power and the track of hurricane Katrina.

(a)



(b)

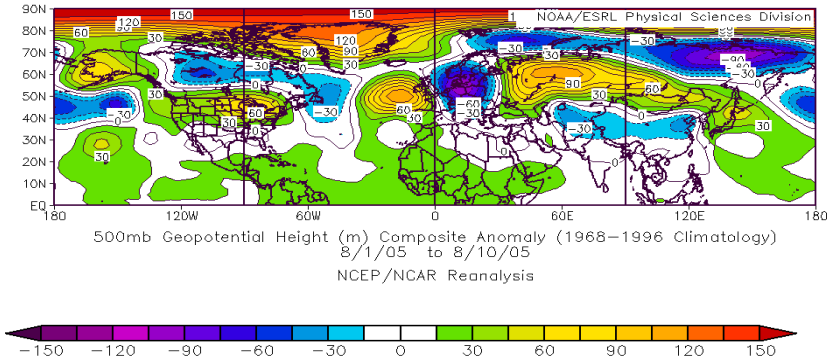
(c)



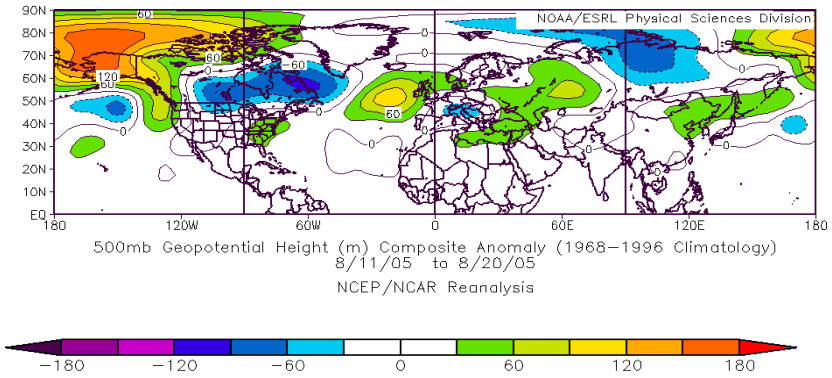
(d)

Fig. 1: Represents the hurricane Katrina image, its track and hazards.
(a) NOAA-15 image of hurricane Katrina on 29 August 2005 at 11:48 UTC.
(b) The track of hurricane Katrina and the growth category, (accuweather.com).
(c) September 4, NASA MODIS Image, New Orleans and Mississippi River delta after hurricane Katrina.
(d) August 9, 2005 NASA MODIS Image, New Orleans and Mississippi Rive delta.

(a)



(b)



(c)

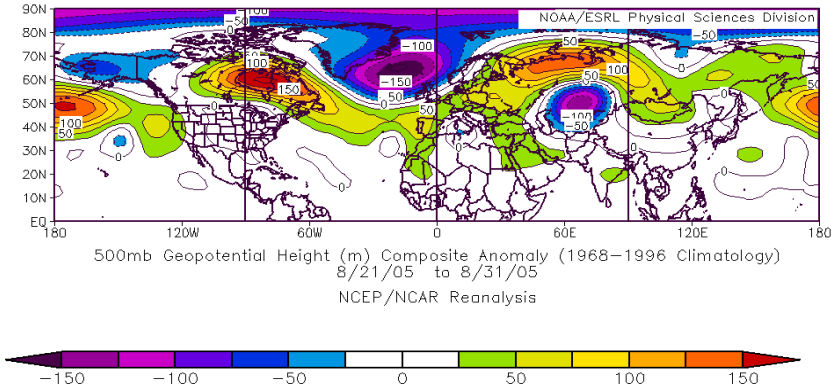


Fig. 2: The 10 - day distribution of the 500 mb geopotential height composite anomaly in the northern hemisphere for periods of (a) 1-10 August 2005, (b) 11-20 August 2005, and (c) 21-31 August 2005.

Table 1: The 10- day mean of the northern hemisphere geopotential height anomalies at 500 mb through the period of 22-31 August 2005.

Region Time period	North America	North Atlantic	Europe	Siberia
1- 10 August 2005	+60 m	+120 m	-90 m	+ 120 m
11-20 August 2005	-120	+120	+60 - 60	+90
21-31 August 2005	+200	-200	+100	+150 -150

Table 2: The daily mean of the northern hemisphere geopotential height anomalies at 500 mb level through The period of 22-31 August 2005.

Region Duration Time	North America	North Atlantic	Europe	Siberia North South
22 August 2005	+150 m	-150 m	+150 m	+150 -150 m
23 August 2005	+150	-200	+150	-150 -150
24 August 2005	+200	-250	-50	+200 -150
25 August 2005	+175	-250	-50	+250 -200
26 August 2005	+200	-200	+50	+200 -200
27 August 2005	+175	-250	+100	+250 -200
28 August 2005	+225	-200	+100	+250 -150
29 August 2005	+250	-175	+150	+250 -175
30 August 2005	+250	-250	+150	+250 -150
31 August 2005	+250	-175	+150	+250 -150

Table 3: The daily mean of anomalies of the meridonal, and zonal wind, and precipitation in the tropical Atlantic and America through the period of 22-31August 2005.

Anomalies / Duration Time	Anomalies of meridonal (m/sec) Eastern America	North Atlantic	Anomalies of Tropical Atlantic precipitation (mm/day)	Anomalies of zonal (m/sec) Eastern America	North Atlantic
22 August 2005	-8	+8	+15	+6	-6
23 August 2005	-4	+10	+15	-6	+8
24 August 2005	-4	+10	+25	-8	+10
25 August 2005	-8	+8	+30	-8	+10
26 August 2005	-10	+10	+50	-6	+18
27 August 2005	-15	+18	+60	-15	+18
28 August 2005	-15	+15	+60	-15	+15
29 August 2005	-15	+21	+90	-10	+15
30 August 2005	-10	+10	+55	-6	+8
31 August 2005	-8	+10	+50	+10	+10

Table 4: The correlation coefficient matrix of the anomalies in the northern hemisphere geopotential height and the anomalies in meridonal, zonal winds and precipitation in the tropical Atlantic region during the period of Hurricane Katrina.

Correlation coefficient	Anomalies in the meteorological elements in regions of Tropical Atlantic (TA) and America				
Anomalies in geopotential height of region	Meridonal wind over TA and eastern America	Meridonal wind over north America	Precipitation in the TA and eastern America	Zonal wind over TA and eastern America	Zonal wind over north America
North America	-0.40	0.36	0.75*	0.01	0.38
North Atlantic	-0.06	0.05	0.03	0.48	-0.39
Europe	-0.30	0.29	0.28	0.30	-0.02
North Siberia	-0.60*	0.28	0.60*	-0.01	0.30
South Siberia	0.34	-0.19	-0.22	0.49	-0.53

(*): means of value with significant level > 95 %

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